Status Report: Renewable Electricity Standard Economic Analysis

The purpose of this document is to provide an update on the ongoing economic analysis of the Renewable Electricity Standard (RES) that the Air Resources Board (ARB or Board) will be proposing in 2010. Governor Schwarzenegger's Executive Order (EO) S-21-09 directed the Board to adopt a regulation consistent with a 33 percent renewable electricity energy target established in the AB 32 Scoping Plan and by EO S-14-08 in July 31, 2010. The rulemaking and the associated analysis will be completed in coordination with the California Public Utilities Commission (CPUC), the California Energy Commission (CEC), the California Independent System Operator (CAISO), and other regulatory agencies as needed.

Economic analysis of proposed ARB regulations is required by law. The required economic analysis for the RES includes:

- Assessment of impacts on California business creation, expansion, or elimination as a result of the proposed regulation.
- Assessment of whether the proposed regulation will create or eliminate jobs.
- Estimates of impacts on affected individuals in California.
- Determination of impacts on small businesses.
- Determination of California business competitiveness with other states.
- Assessment of the impacts to determine that activities undertaken to comply with the regulations do not disproportionately impact low-income communities.

Implementation of a 33 percent RES could lead to increases in customers' energy bills. The economic impact methodology evaluates the increase in business and residential monthly bills and the effects on business creation, competitiveness and employment that may result from the increase in electric bills.

RES Calculator

The incremental cost of implementing a 33 percent Renewable Electricity Standard was estimated using the 33 percent RES Calculator (Calculator) developed by Energy and Environmental Economics (E3). The Calculator is based on the calculator previously developed by E3 and used for the CPUC 33 percent Renewable Portfolio Standard (RPS) Implementation Analysis[1]. However, the 33 percent RES Calculator was updated to include the most recent

[1] The Calculator and further information are available at the CPUC web site at http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/33implementation.htm.

data, where available, and to capture some of the regulatory differences between the RPS and the RES.

Based on the amount of electricity needed to meet demand in 2020 the Calculator estimates the amount and type of renewable energy needed to meet a renewable goal in 2020. For this analysis, the Calculator produces estimates of the renewable mix necessary to meet the current 20 percent RPS in 2020 and the renewable mix necessary to meet the proposed 33 percent RES in 2020. Using these renewable resource mixes, the Calculator estimates the costs and revenue required to meet the renewable electricity targets in 2020. The Calculator then estimates the incremental cost of meeting the 33 percent RES target over the current 20 percent RPS target.

The incremental costs will be estimated for four different compliance scenarios that are illustrative examples of possible compliance pathways for the 33 percent RES. The compliance scenarios are based on two different regulatory structures, one allowing only bundled Renewable Energy Credits (RECs) to count toward RES compliance and the other allowing for unlimited unbundled undelivered RECs to be used for compliance.

For both of these regulatory structures two load scenarios are assessed. The first, a High Net Load scenario approximates a case in which some Combined Heat and Power (CHP) and Solar Distributed Generation (Solar DG) are incorporated into the load forecast for 2020, but none of the load reductions attributable to the Energy Efficiency, enhanced Solar DG and CHP measures in the AB 32 Scoping Plan are included. The High Net Load demand is 290,000 gigawatt hours (GWh) in 2020. The second is a Low Net Load scenario which incorporates full implementation of AB 32 Scoping Plan electricity sector measures as well as the embedded values found in the High Net Load scenario. For the Low Net Load scenario Energy Efficiency reduces the total load by 24,400 GWh, CHP reduces the load by 30,222 GWh, and Solar DG reduces the load by 2,030 GWh. These load reduction result in a total load demand of 250,000 GWh in 2020.

To calculate the estimated incremental cost of implementing the 33 percent RES over the 20 percent RPS a High and Low Net Load 20 percent compliance baseline scenario must also be estimated by the Calculator. Table 1 summarizes the illustrative compliance scenarios that will be used to estimate the incremental compliance cost.

Table 1. Plausible Compliance Scenario Model Runs

Model Run Completed for Year 2020	2009 IEPR Load Forecast for Year 2020
20 percent RPS	High Net Load
20 percent RPS	Low Net Load
33 percent RES with bundled RECs	High Net Load
33 percent RES with bundled RECs	Low Net Load
33 percent RES with unbundled RECs	High Net Load
33 percent RES with unbundled RECs	Low Net Load

Cost Estimates

The Calculator was used to estimate the revenue requirement for each of the compliance scenarios described above. The revenue requirement falls into eight categories:

1. Existing Transmission and Distribution Costs
2. Existing Generation Fixed Costs
3. Existing Generation Variable Costs
4. New Conventional Fixed Costs
5. Existing and New Conventional Variable Costs
6. Incremental Demand Response Cost
7. New Renewables Build
8. New Transmission for Renewables

Each of the six scenarios' renewable electricity requirements are estimated to be met with a different mix of renewable resources. Each mix has a different amount of cost and revenue required. The cost and revenue requirement for each compliance scenario is based on the load demand, amount of renewable generation required, the renewable resource mix, location of the resources, and transmission required, among other factors. For this workshop update, preliminary incremental cost estimates have been completed for the 33 percent RES bundled REC high and low load scenarios[2].

Tables 2 and 3 show the eligible renewable resources and the amount of each renewable resource needed to meet renewable goals, as generated by the RES Calculator, for each load scenario. The first column lists the renewable resources. The second column shows the amount of each renewable resource that would be generated in 2020 to meet the baseline 20 percent RPS goal. The third column shows the amount of each renewable resource that would be generated to meet the 33 percent RES goal in 2020. Column four shows the

[2] Staff expects full results of the economic analysis, including the unbundled REC scenario analysis, to be completed by the end of May.

additional electricity generated, by renewable resource, to meet the 33 percent RES over the 20 percent RPS. The fifth column shows the percentage makeup of the incremental renewable mix.

Table 2. Renewable Mix in 2020 with Bundled RECs, Low Load

Renewable Resource	20% RPS in 2020 (GWh)	33% RES in 2020 (GWh)	Difference between 20% RPS and 33% RES (GWh)	Percentage of Incremental Renewable Mix
Small Hydro	4,397	4,417	20	0.06%
Biomass	6,355	8,210	1,855	5.72%
Landfill/digester Gas	2,155	2,297	142	0.44%
Geothermal	14,458	23,253	8,795	27.10%
Solar PV	438	6,471	6,033	18.59%
Solar Thermal	978	13,532	12,554	38.69%
Wind	21,124	24,175	3,051	9.40%
Total	49,905	82,355	32,450	100.00%

Table 3. Renewable Mix in 2020 with Bundled RECs, High Load

Renewable Resource	20% RPS in 2020 (GWh)	33% RES in 2020 (GWh)	Difference between 20% RPS and 33% RES (GWh)	Percentage of Incremental Renewable Mix
Small Hydro	4,401	4,417	16	0.04%
Biomass	6,355	8,210	1,855	4.96%
Landfill/digester Gas	2,270	2,931	660	1.76%
Geothermal	20,953	24,597	3,644	9.74%
Solar PV	718	6,887	6,169	16.49%
Solar Thermal	978	16,428	15,451	41.29%
Wind	21,874	31,497	9,623	25.72%
Total	57,549	94,966	37,418	100.00%

Table 4 shows the revenue requirement needed to meet the 20 percent RPS in 2020 at both the high and low load, the 33 percent RES in 2020 for both the high and low load, and the incremental cost for both load scenarios.

Table 4. Estimated Compliance Revenue Requirement in 2020[3] (in Millions of 2008 $)

	20% RPS		33% RES, Bundled RECs		Incremental Change	
	High	Low	High	Low	High	Low
Existing Transmission and Distribution Costs	$20,164	$19,361	$20,164	$19,361	$0	$0
Existing Generation Fixed Costs	$8,547	$8,547	$8,547	$8,547	$0	$0
New Conventional Fixed Costs	$4,255	$2,675	$2,833	$1,371	($1,421)	($1,304)
Existing and New Conventional Variable Costs	$10,956	$9,226	$9,080	$7,598	($1,876)	($1,629)
New Renewables Build	$2,771	$1,959	$8,458	$6,951	$5,688	$4,992
New Transmission for Renewables	$309	$205	$1,458	$1,219	$1,149	$1,014
Total Revenue Requirement	$47,002	$41,973	$50,541	$45,047	$3,539	$3,073

Economic Impacts

EDRAM

The model used for the RES macroeconomic analysis is a modified version of the Environmental-Dynamic Revenue Analysis Model (EDRAM), a computable general equilibrium (CGE) model. The EDRAM was built by researchers at the University of California, Berkeley. As a CGE model, EDRAM is designed to

[3] The Incremental Demand Response Cost is zero for all scenarios.

capture the fundamental economic relationships between producers, consumers, and government. CGE models are not forecasting models; they are calibrated to reproduce a base year. In the case of EDRAM, the model is constructed to exactly reproduce the economic conditions of calendar year 2003.

The EDRAM describes the relationship among California producers, California households, California governments, and the rest of the world. Rather than tracking each individual producer, household, or government agency in the economy, however, EDRAM combines similar agents into single sectors. That is, the EDRAM, like all other empirical economic models, treats aggregates rather than individual agents.

For industrial sectoring purposes, all California firms making similar products are lumped together. The fabricated structural metal manufacturing sector (manufacturing), for example, contains all California firms producing metal manufacturing products. The output value of that sector is the value of all metal manufacturing firms in California. A sector's labor demand is the sum of labor used by all firms in the sector. Along with manufacturing, there are 119 other producer aggregates in the model. These aggregates generally represent the major industrial and commercial sectors of the California economy. In summary, firms, also known as producers, are aggregated into industrial sectors, and each sector is modeled as a competitive firm.

EDRAM Results

Low Load Scenario

The RES Calculator was used to estimate the cost and revenue requirement for a mix of renewables sufficient to meet the 33 percent target in 2020 for a low load and a high load plausible compliance scenario. This section shows the results of the EDRAM analysis for the Low Net Load scenario.

Scenario details

Tables 5 and 6 show data from the RES Calculator 20 percent RPS in 2020 and 33 percent RES with bundled RECs in 2020 plausible compliance scenario runs as well as other energy agency sources. This cost and resource mix information is used to derive inputs for EDRAM. Table 5 contains the data used for the 20 percent RPS baseline scenario in EDRAM and Table 6 has the data used for the 33 percent RES bundled REC scenario in EDRAM.

Table 5. Baseline Low Net Load Scenario, 20 Percent RPS in 2020

Renewable Resources	2008 Resources[4]	2020 Resources[5]	Additional Resources Selected[6]	2020 Delivered Cost[7]	2020 Total Renewable Delivered Cost[8]	2020 Avoided Conventional Cost[9]
(2020 @ 20%)	(GWh)	(GWh)	(GWh)	($2008/ MWh)	(Billion $2008)	(Billion $2008)
Biogas	0	223	223	$101	$0.023	$0.023
Biomass	5,880	8,035	2,155	$176	$1.412	$0.847
Geothermal	12,596	13,928	1,332	$103	$1.438	$1.468
Hydro - Small	4,072	4,229	157	$139	$0.587	$0.446
Solar PV	0	438	438	$233	$0.102	$0.046
Solar Thermal	688	949	261	$195	$0.185	$0.100
Wind	6,759	20,843	14,084	$104	$2.169	$2.197
Total	29,995	48,644	18,901		$5.915	$5.129

[4] The 2008 Resources column shows the current renewable-generating electricity for consumption in California. These are based on a CEC study (CEC, 2009), accounting for a 7.8% loss of electricity transmission and distribution.

[5] The 2020 Resources column is the sum of the Additional Resources Selected column and the 2008 Resources column. It informs what types and how much of a renewable resource is needed to meet the 2020 20% RPS target.

[6] The column titled Additional Resources Selected represents the incremental renewable resources selected, on top of the current renewable-generating electricity, to meet the 2020 electricity demand in California. These data are extracted from running E3's RES Calculator model updated in October 2009 (CPUC, 2009).

[7] The 2020 delivered cost column is the overall unit cost of energy, including electricity generation, transmission, and integration where applicable. These data are taken from E3's RPS Calculator model (CPUC, 2009).

[8] The 2020 expenditure column refers to the total cost for generating electricity from renewable resources in 2020.

[9] We estimate savings resulting from avoided conventional electricity by using the overall cost of NGCC electric generation of $105/MWh, which is the 2020 delivered cost of NG-based electricity (CPUC, 2009).

Table 6. Bundled RECs Low Net Load Scenario, 33 Percent RES in 2020

Renewable Resources	2008 Resources	2020 Resources	Additional Resources Selected	2020 Delivered Cost	2020 Total Renewable Delivered Cost	2020 Avoided Conventional Cost
(2020 @ 33%)	(GWh)	(GWh)	(GWh)	($2008/ MWh)	(Billion $2008)	(Billion $2008)
Biogas	0	2,078	2,078	$98	$0.203	$0.219
Biomass	5,880	8,176	2,297	$176	$1.436	$0.862
Geothermal	12,596	22,724	10,127	$111	$2.529	$2.396
Hydro - Small	4,072	4,249	177	$139	$0.590	$0.448
Solar PV	0	6,471	6,471	$233	$1.506	$0.682
Solar Thermal	688	13,503	12,815	$193	$2.607	$1.424
Wind	6,759	23,894	17,135	$104	$2.493	$2.519
Total	29,995	81,093	51,099		$11.364	$8.550

Modeling inputs

Staff used EDRAM to estimate the impact of the RES program on California's statewide economy. EDRAM's baseline scenario assumes no or little renewable electricity in 2020. Therefore in order to estimate the incremental impact of 33 percent RES over the 20 percent RPS, a 20 percent RPS scenario was developed and run in EDRAM and then the 33 percent RES scenario was run. The difference in economic indicators such as gross state product and statewide employment for these two scenarios provides and estimate of the statewide economic impacts of 33 percent RES relative to the currently required 20 percent RPS.

In order for EDRAM to estimate the impacts of RES on the statewide economy the economic activity related to the build out of renewables must be assigned to the appropriate economic sectors. The economic sectors most affected by

renewable electricity are identified in Table 7. The economic activity associated with building and operating renewable electricity generation is closely related to the following industrial sectors used in EDRAM: agricultural sector (agriculture), industrial building construction sector (construction), and fabricated structural metal manufacturing sector (manufacturing). For each type of renewable resource it was estimated what percentage of the money spent on that resource would go to each affected sector. For example, for every $100 spent on generating electricity from biomass, it was estimated that $23 is spent in the agricultural sector, $27 is spent in the industrial construction sector, and $50 is spent in the metal manufacturing sector. The percentage assumptions for each type of resource were based on literature review[10].

Table 7. Percent allocation of electricity-generating expenditure to relevant EDRAM sectors

Renewables	Agriculture	Construction	Manufacturing
Biogas	0%	50%	50%
Biomass	23%	27%	50%
Geothermal	0%	50%	50%
Hydro - Small	0%	35%	65%
Solar PV	0%	35%	65%
Solar Thermal	0%	35%	65%
Wind	0%	25%	75%

[10] References relied on for sector allocation include:

1. Bolinger, Mark, 2009. An Update on U.S. Wind Power Prices and the Factors That Influence Them. Presentation at the WINDPOWER 2009, Chicago, Illinois. Lawrence Berkeley National Laboratory. May 5.

2. Krohn, Søren, Poul-Erik Morthorst, and Shimon Awerbuch, 2009. The Economics of Wind Energy: A report by the European Wind Energy Association. European Wind Energy Association. March.

3. Wiser, Ryan, Galen Barbose, Carla Peterman, and Naïm Darghouth, 2009. Tracking the Sun II: The Installed Cost of Photovoltaics in the U.S. from 1998-2008. Lawrence Berkeley National Laboratory. October.

4. CPUC, 2009. 33% RPS Implementation Analysis. 33% RPS Calculator. Updated October 22, 2009.

EDRAM assumes since there is more money being spent in the industry sectors related to renewables there is less money being spent in the sector representing conventional electricity generation. This translates to less spending from the conventional electricity sector to its supply source: California's fossil fuel extraction sector, mainly natural gas[11]. Tables 8 and 9 show the economic transactions between industrial sectors. This is the amount of money that is no longer being spent in the conventional electricity sector and in which sectors it is now being spent for the baseline and RES scenarios.

Table 8. Aggregate impacts in the 20 Percent RPS baseline scenario as input to EDRAM

To-Sector	From-Sector	Aggregate Impacts ($ Billion)
Construction	Conventional Electricity	1.960
Manufacturing	Conventional Electricity	3.631
Fuel Extraction	Conventional Electricity	-5.129

Table 9. Aggregate impacts in the 33 Percent RES active scenario as input to EDRAM

To-Sector	From-Sector	Aggregate Impacts ($ Billion)
Construction	Conventional Electricity	4.023
Manufacturing	Conventional Electricity	7.011
Fuel Extraction	Conventional Electricity	-8.550

Results

Once the flow of money through the different economic sectors is assigned EDRAM can be run. The results derived from running EDRAM, for scenario year 2020 and in 2008 dollars, are summarized below.

[11] California imports much of its natural gas supply from out of state. It is likely that less demand for natural gas will result in decreased imports, rather than less in-state production, resulting in a small impact on California's fossil fuel extraction sector.

Table 10 shows EDRAM's estimates of the overall net impacts of RES on California's economy. As explained earlier, staff ran the 20 percent RPS baseline scenario and then the 33 percent RES with bundled RECs plausible compliance scenario in EDRAM. The difference between these two scenarios is the incremental impact of RES. Based on this preliminary run, RES is estimated to have a very small impact on statewide economic indicators.

Table 10. EDRAM results for the overall net effects on California's economy

	20% RPS	33% RES	Incremental Impact	Percent Impact
Output ($Billion)	3789.36	3789.54	0.18	0.00%
Gross state product (GSP, $Billion)	2687.20	2687.65	0.45	0.02%
State personal income (SPI, $Billion)	2173.60	2173.66	0.05	0.00%
Employment (Thousand)	18,428	18,429	1	0.00%

EDRAM also estimated the impacts of the policy on individual economic sectors. Tables 11-14 present the potential impacts of RES on the economic sectors which are closely related to the implementation of RES. EDRAM estimates the impacts on all 120 sectors included in the model, however many sectors will have minor impacts (e.g., well under 1 percent increase or decrease). This update is illustrative and provides the impacts from a sample of sectors where the impact is at a least a few percent. .

Table 11 shows the impact of 33 percent RES on the construction sector. Production goes up in this sector, as expected, because this sector will benefit as more renewable electricity resources are built.

Table 11. EDRAM results for industrial building construction sector

	20% RPS	33% RES	Incremental Impact	Percent Impact
Real output ($ Billion)	23.35	25.02	1.67	7.1%
Employment (Thousand)	104.507	112.038	7.530	7.2%

Table 12 presents the impacts on the conventional electricity sector. The modeled scenarios assume renewable electricity displaces output from the conventional electricity sector; therefore its production goes down, as expected.

Table 12. EDRAM results for conventional electricity supply sector

	20% RPS	33% RES	Incremental Impact	Percent Impact
Real output ($ Billion)	34.88	32.15	-2.74	-7.8%
Employment (Thousand)	21.016	19.314	-1.702	-8.1%

Table 13 shows, as expected, production in the metal manufacturing sector goes up. This is because this sector will benefit as more renewable electricity resources are built.

Table 13. EDRAM results for fabricated structural metal manufacturing sector

	20% RPS	33% RES	Incremental Impact	Percent Impact
Real output ($ Billion)	41.78	44.56	2.78	6.7%
Employment (Thousand)	188.223	200.992	12.768	6.8%

Table 14 shows the impacts of RES on California's domestic fossil fuel extraction sector. EDRAM assumes when California's demand for fossil fuels (mainly natural gas) goes down, the import of fossil fuels is cut accordingly and its production stays almost constant[12]. The table shows the fuel extraction sector will reduce its imports by almost 4 percent in the 33 percent low load growth scenario.

[12] This is consistent with how the California market has historically reacted to marginal changes in demand for fossil fuels.

Table 14. EDRAM results for the fossil fuel extraction sector

	20% RPS	33% RES	Incremental Impact	Percent Impact
Real output ($ Billion)	8.27	8.32	0.05	0.6%
Employment (Thousand)	2.666	2.684	0.017	0.71%
Import ($ Billion)	91.41	88.00	-3.41	-3.7%
Export ($ Billion)	39.19	39.16	-0.02	-0.1%

High Load Scenario

The EDRAM analysis was also conducted using the RES Calculator results for the high net load scenarios. This section shows the analysis for the High Net Load scenarios.

Scenario details

Tables 15 and 16 show data from the RES Calculator 20 percent RPS in 2020 and 33 percent RES with bundled RECs in 2020 plausible compliance scenario runs as well as other energy agency sources. This cost and resource mix information is used to derive inputs for EDRAM. Table 15 contains the data used for the 20 percent RPS baseline scenario in EDRAM and Table 16 has the data used for the 33 percent RES bundled REC scenario in EDRAM.

Table 15. Baseline High Net Load Scenario, 20 Percent RPS in 2020

Renewable Resources	2008 Resources	2020 Resources	Additional Resources Selected	2020 Delivered Cost	2020 Total Renewable Delivered Cost	2020 Avoided Conventional Cost
(2020 @ 33%)	(GWh)	(GWh)	(GWh)	($2008 MWh)	(Billion $2008)	(Billion $2008)
Biogas	0	223	223	$102	$0.023	$0.023
Biomass	5,880	8,150	2,270	$176	$1.438	$0.859
Geothermal	12,596	20,424	7,827	$112	$2.285	$2.153
Hydro-Small	4,072	4,232	161	$140	$0.591	$0.446
Solar PV	0	718	718	$234	$0.168	$0.076
Solar Thermal	688	949	261	$196	$0.186	$0.100
Wind	6,759	21,593	14,834	$105	$2.264	$2.277
Total	29,995	56,288	26,294		$6.954	$5.934

Table 16. Bundled RECs High Net Load Scenario, 33 Percent RES in 2020

Renewable Resources	2008 Resources	2020 Resources	Additional Resources Selected	2020 Delivered Cost	2020 Total Renewable Delivered Cost	2020 Avoided Conventional Cost
(2020 @ 33%)	(GWh)	(GWh)	(GWh)	($2008/ MWh)	(Billion $2008)	(Billion $2008)
Biogas	0	2,078	2,078	$98	$0.204	$0.219
Biomass	5,880	8,810	2,931	$169	$1.486	$0.929
Geothermal	12,596	24,068	11,471	$110	$2.658	$2.537
Hydro - Small	4,072	4,249	177	$140	$0.594	$0.448
Solar PV	0	6,887	6,887	$234	$1.608	$0.726
Solar Thermal	688	16,399	15,711	$195	$3.201	$1.729
Wind	6,759	31,216	24,457	$105	$3.267	$3.291
Total	29,995	93,706	63,711		$13.018	$9.879

Modeling Inputs

Tables 17 and 18 show the flow of money through the industry sectors most related to the renewable electricity sector as explained in the previous section.

Table 17. Aggregate impacts in the 20 Percent RPS baseline scenario as input to EDRAM

To-Sector	From-Sector	Aggregate Impacts ($ Billion)
Construction	Conventional Electricity	2.439
Manufacturing	Conventional Electricity	4.185
Fuel Extraction	Conventional Electricity	-5.934

Table 18. Aggregate impacts in the 33 Percent RES active scenario as input to EDRAM

To-Sector	From-Sector	Aggregate Impacts ($ Billion)
Construction	Conventional Electricity	4.540
Manufacturing	Conventional Electricity	8.136
Fuel Extraction	Conventional Electricity	-9.879

Results

Tables 19 through 23 show the results of the EDRAM analysis for the high load scenarios.

Table 19 shows the overall net impacts of RES on California's economy. As with the low load scenario, RES is shown to have a very small impact on statewide economic indicators.

Table 19. EDRAM results for the overall net effects on California's economy

	20% RPS	33% RES	Incremental Impact	Percent Impact
Output ($Billion)	3790.06	3791.15	1.09	0.03%
Gross state product (GSP, $Billion)	2687.99	2689.37	1.38	0.05%
State personal income (SPI, $Billion)	2174.12	2174.79	0.67	0.03%
Employment (Thousand)	18,430	18,434	3	0.02%

Tables 20-23 present the potential impacts of RES on the economic sectors which are closely related to the implementation of RES.

Table 20 shows the impact of 33 percent RES on the construction sector. Production goes up in this sector, as expected, because this sector will boom to assist in generating renewable electricity.

Table 20. EDRAM results for industrial building construction sector

	20% RPS	33% RES	Incremental Impact	Percent Impact
Real output ($ Billion)	23.80	25.45	1.65	7.0%
Employment (Thousand)	106.510	113.990	7.479	7.0%

Table 21 presents the impacts on the conventional electricity sector. The model assumes no renewable electricity comes from the conventional electricity sector; therefore its production goes down, as expected.

Table 21. EDRAM results for conventional electricity supply sector

	20% RPS	33% RES	Incremental Impact	Percent Impact
Real output ($ Billion)	34.54	31.71	-2.83	-8.2%
Employment (Thousand)	20.798	19.039	-1.759	-8.5%

Table 22 shows, as expected, production in the metal manufacturing sector goes up. This is because this sector will boom to assist in generating renewable electricity.

Table 22. EDRAM results for fabricated structural metal manufacturing sector

	20% RPS	33% RES	Incremental Impact	Percent Impact
Real output ($ Billion)	42.29	45.48	3.19	7.5%
Employment (Thousand)	190.564	205.163	14.617	7.7%

Table 23 shows the impacts of RES on California's domestic fossil fuel extraction sector. EDRAM assumes when California's demand for fossil fuels (mainly natural gas) goes down, the import of fossil fuels is cut accordingly and its production stays almost constant. The table shows the fuel extraction sector will reduce its imports by 4 percent in the high load growth scenario and the negative impact in the fossil fuel sector will be felt outside California.

Table 23. EDRAM results for the fossil fuel extraction sector

	20% RPS	33% RES	Incremental Impact	Percent Impact
Real output ($ Billion)	8.29	8.55	0.26	3.1%
Employment (Thousand)	2.673	2.758	0.085	3.2%
Import ($ Billion)	90.61	86.68	-3.92	-4.3%
Export ($ Billion)	39.18	39.14	-0.04	-0.1%

Summary of Economic Impacts

The macroeconomic model EDRAM has been applied to estimate the impacts of a 33 percent RES under both low and high load growth scenarios assuming all RECs are bundled with the electricity produced. This provides insights into the potential range of the economic impacts that RES will have.

In the low and high load scenarios that require bundled RECs, the preliminary analysis indicates that RES will have a small impact on California's macro indicators. Specifically, the preliminary analysis indicates that the economic impacts of the RES are imperceptible given by the size of the California economy. The results are preliminary and will be augmented when additional scenarios are run.

The results are preliminary and will be augmented when additional scenarios are run.

Rate Impacts

The cost to implement RES is expected to be passed on to rate payers in the form of increases in rates for electricity. To estimate the rate impacts of RES staff will work with the CPUC. The CPUC's rate payer calculator will be used to estimate both the percent increase in rates and the impact these increased rates will have on the monthly bills in different rate payer categories in 2020.

Rates are expected to increase in 2020 regardless of the implementation of RES. The rate payer calculator takes this into consideration and then estimates the portion of rate increase attributable to RES. The rate increase attributable to RES is calculated based on the incremental cost of implementing a 33 percent RES compared to the 20 percent RPS in 2020.

Residential Customer Rate Impacts

An increase in electric rates will impact residential utility customers' monthly bills differently depending on energy consumption. Residential rates are tiered, resulting in customers being charged higher rates for higher levels of usage. Using the rate payer calculator staff will evaluate the rate impacts on a high, medium and low usage customer. The cost to implement the program will have a direct effect on the change in rates. Staff will estimate the rate impacts for the four plausible compliance scenarios on residential customers.

Low Income Residential Customer Rate Impacts

Low income customers qualify for rate subsidies. In order to consider bill impacts on low income customers, staff will evaluate the rate impacts on customers enrolled in the low-income California Alternative Rates for Energy (CARE) program and consider impacts on customers not enrolled the CARE program. The rate impact calculator will be used to estimate the percent rate increase for low income customers, as well as their monthly bill impact.

Small Business Rate Impacts

Small businesses in California are expected to be impacted by ARB's RES in the form of changes in expenditure on electricity stemming from rate impacts. The rate impact calculator will be used to estimate the change in electricity rates for certain types of businesses as a result of RES in 2020. Electricity rates for small business are expected to increase between now and 2020 regardless of the implementation of RES. The rate and bill impacts will be calculated based on the incremental cost of implementing a 33 percent RES in 2020 over the currently mandated 20 percent RPS in 2020. The rate impact calculator identifies the portion of rate increase in 2020 that can be attributed to the implementation and fulfillment of the 33 percent RES by the Investor Owned Utility companies.

Impact on Businesses

When adopting a regulation, the ARB is required to consider its potential impacts on business, particularly small business. California businesses are likely to experience an increase in electricity expenditure as a result of Renewable Electricity Standard (RES) in 2020. Using the 33 percent RES Calculator, staff will calculate the electricity rate increases and associated increase in electricity expenditure for businesses in different industries. Overall, we expect RES to result in a small increase in electricity expenditure for average California businesses relative to business-as-usual. This analysis does not reflect energy efficiency measures that a given business may choose to adopt that could reduce electricity expenditures.

The analysis for business impacts will provide a financial assessment of the impacts of the RES on California businesses. The assessment will include the following topics.

- Average electricity bill impacts for all California business types.
- Comparison of Small business spending on electricity as a percent of revenue to large business spending on electricity as a percent of revenue.
- Change in California business ranking in terms of electricity expenditures per dollar of sales in the nation as a result of RES.
- Ability of a Small business versus a large business to be more responsive to the changes required by the RES because of their ability to invest in energy efficient technologies to achieve energy savings.

Green Job Impacts

The employment impacts of renewable electricity generation have been estimated for several different technologies, using different types of models and varied sets of assumptions and constraints. Estimating the aggregate employment impact of the RES, therefore, requires normalization of employment factors across heterogeneous studies. To evaluate the employment impacts of the proposed regulation, ARB will apply normalized RES employment factors drawn from 10 different studies issued by private, public and non-governmental entities. RES employment factors are expressed in terms of net new permanent jobs created per average MW of renewable generating capacity added. ARB will apply normalized RES employment factors to the renewable resource outputs of the RES Calculator for both high load growth and low load growth runs of the bundled and unbundled REC scenarios.

Next Steps

ARB staff has conducted a preliminary assessment of two 33 percent RES with bundled RECs compliance scenarios to demonstrate the economic analysis methodology and models. Staff will continue to work on the analysis of the impacts of RES including the impact on rate payers, small businesses, and green jobs. Ongoing analysis will also include the impacts of the 33 percent RES with unbundled RECs plausible compliance scenarios.